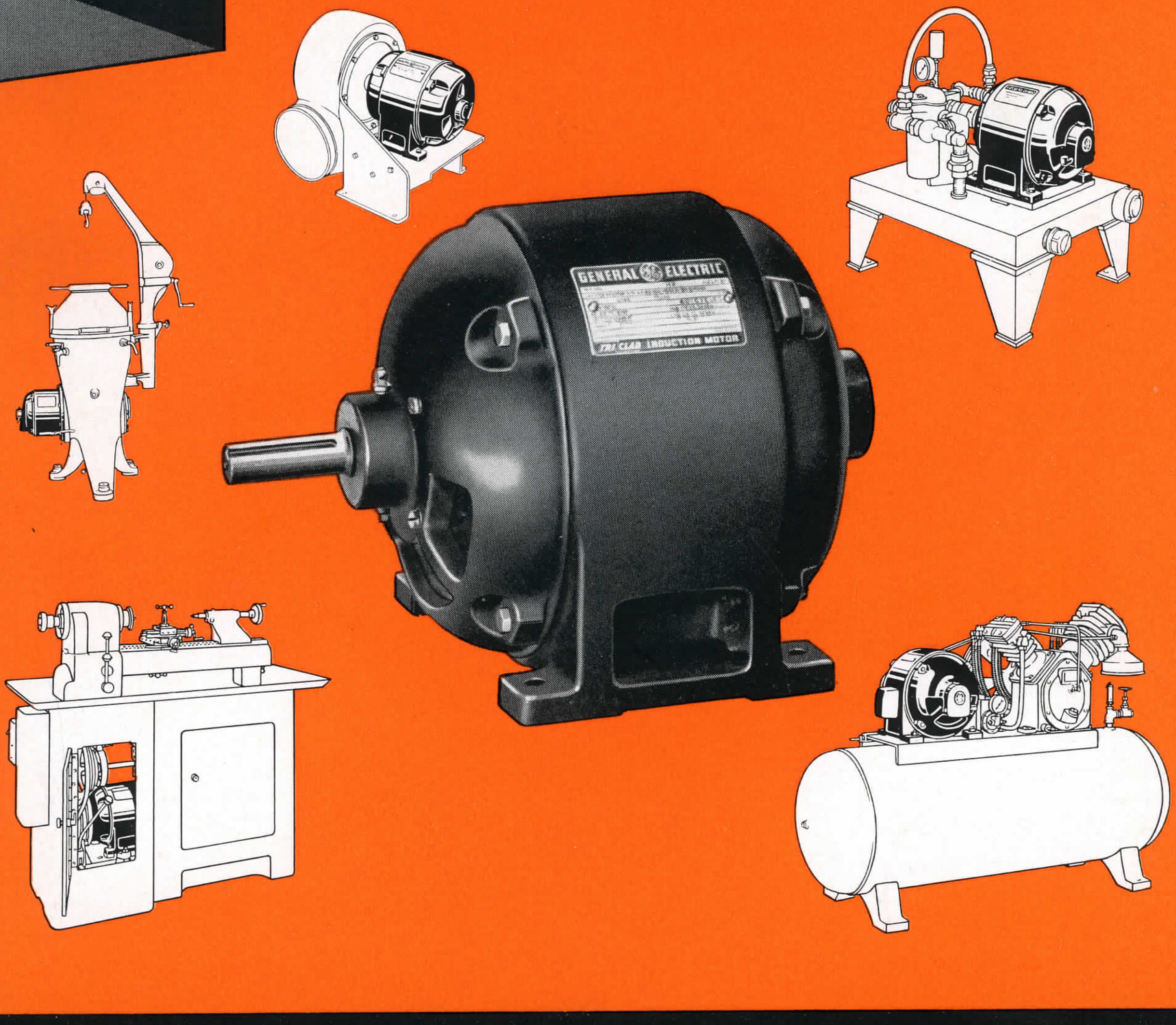
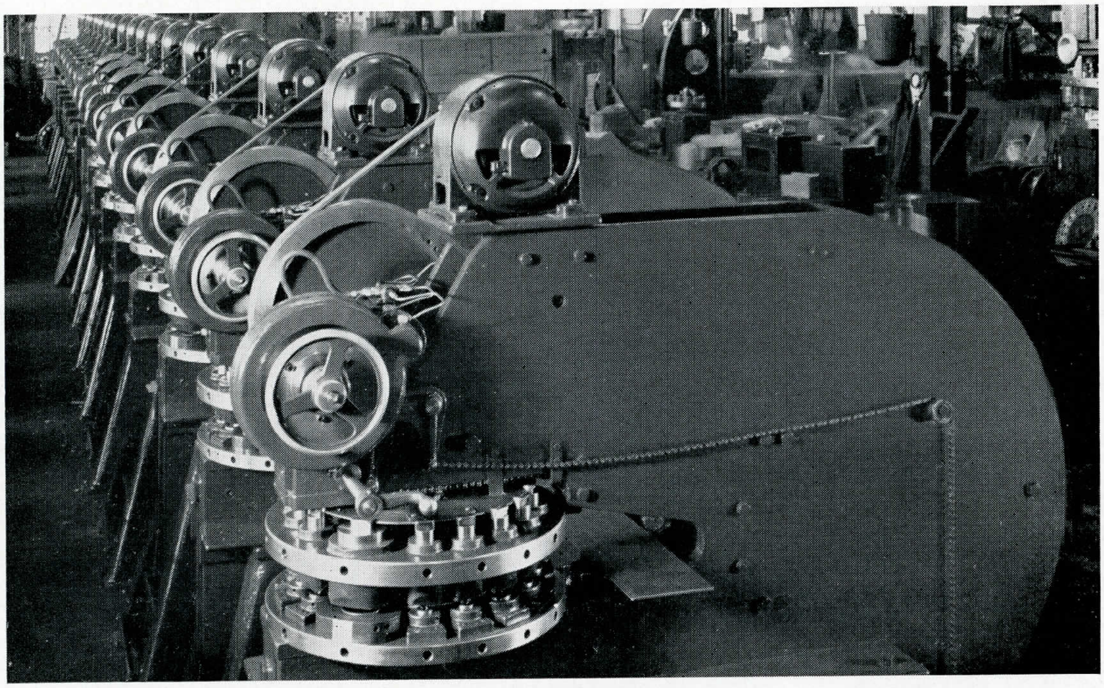
GEA-4092

MAKING MOTORS A PART OF YOUR PRODUCT

—with references to features of G-E motors that are of particular advantage to the machinery manufacturer



GENERAL ELECTRIC



G-E Tri-Clad Motors in process of installation on a battery of small turret presses.

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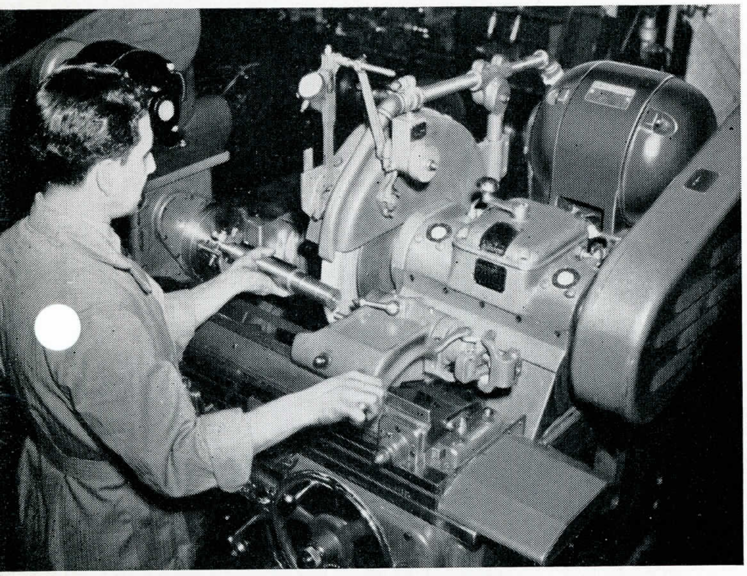
NOTE: Although a large portion of this publication is devoted to Tri-Clad motors, other types are also included.

STANDARD MOTORS — Use Them for Economy on Many Jobs

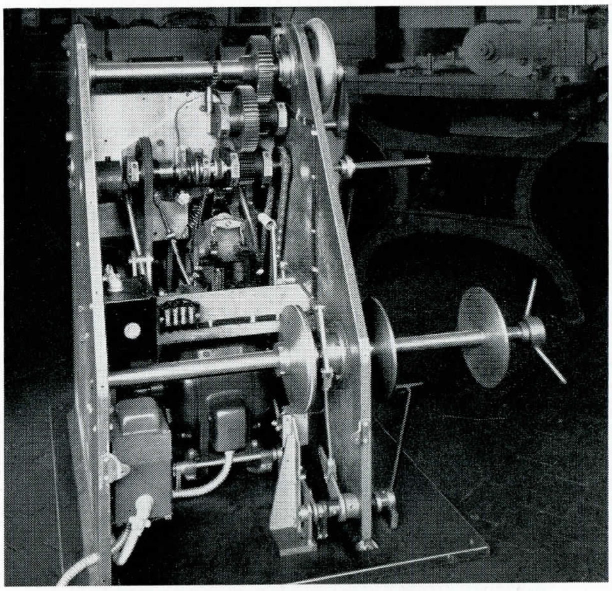
STANDARD foot-mounted motors are suitable for a wide variety of applications—for lathes, grinders, and other machine tools as well as for pumps, blowers, stokers, and innumerable other kinds of machinery. They are suitable for direct coupling as well as for coupling by means of power-transmitting devices, such as belts and gears. With the exception of applications where extremely close centers, unusually close coupling, or end-shield mounting is essential, there are few limitations on the use of modern standard motors.

Wherever they can be used, standard motors will usually be found more convenient than nonstandard motors, for a number of reasons among which are:

> Standard motors are less expensive than nonstandard.
>
> Standard motors can be shipped sooner.
>
> They are simply and quickly installed, because they are self-contained, easily handled units that need little of the care that is often necessary in the assembly of nonstandard motors on machines.
>
> Standard motors can often be shifted from one job to another in an emergency. Nonstandard motors, on the other hand, are usually built for one job only.



Standard, open, sleeve-bearing Tri-Clad motor driving the grinding wheel of a cylindrical grinder. Here's an example of how smoothly the lines of the Tri-Clad motor blend with those of the machine.



Standard, open, ball-bearing motor installed in a semiautomatic coil winder. Appearance was of little importance in this application—but compactness and easy handling were.

These Motors Are Some of the Many Standard Types

Open	Enclosed fan-cooled
Splashproof	Explosion-proof
Single-speed	Normal-starting-torque
Multispeed	High-starting-torque
Sleeve Bearing	Horizontal
Ball Bearing	Vertical

The photographs on this page illustrate two of the many instances in which standard motors have been made—conveniently—a part of modern machines. The Tri-Clad motors shown are particularly suitable for applications such as these because all the standard motors in the Tri-Clad motor line have every one of these features that were once considered "special":

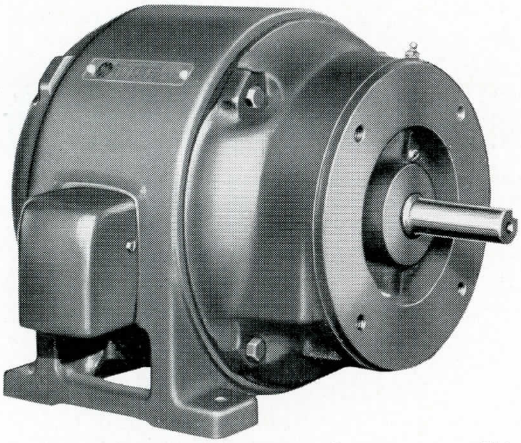
> The smooth contours blend with modern machinery and tend to shed falling dirt and dripping fluids.
>
> Close-tolerance machining of the mounting surfaces and the adaptability of the four-position end shields and conduit box make the assembling of the motor to the machine a comparatively simple matter.
>
> Dynamic balance of Tri-Clad rotors results in a motor that matches modern precision machinery in operating smoothness.
>
> The windings—of Formex wire—have great insulation strength even against the effects of heat, oil, moisture, and abrasion.

FACE-TYPE MOTORS—Use Them Where the Motor Supports the Machine

Face-type end-shield motors are mechanical modifications of standard motors that have proved highly useful when such equipment as pumps, fans and blowers, compressors, and hoists can be mounted directly on the driving motor.

Mounting a machine to a motor with a face-type end shield is an extremely simple operation, accomplished by fastening the motor and the driven machine together by bolts which screw into tapped holes in the machined end shield of the motor.

This type of mounting is generally used where the driven machine is to overhang the motor.



Tri-Clad face-type end-shield motor for foot mounting. This is a well-protected drive generally used for machines that can be overhung from the motor.

Face-type End-shield Motors Provide These Advantages

1. Your Assembly Costs Are Reduced

To assemble the machine and the motor, it is necessary only to bolt the machine to the motor and join its coupling to the motor shaft. Because the face-type end shield has a machined surface and rabbet, this simple assembly provides immediate, accurate alignment of motor and driven machine. The unit is ready immediately to give long and satisfactory service.

2. Development Expense Is Lowered

A wide choice of motors of various mechanical and electrical constructions has the same end-shield mounting dimensions. Because of this simplification and flexibility, a number of motors of different ratings or types of enclosure can be adapted to different installation requirements with little or no change in machine design.

For example, the accompanying tabulation shows that only three sets of face-type end-shield mounting dimensions are used for all Tri-Clad motors from Frame 203 to Frame 505, both inclusive. This covers ratings ranging from 1 hp through 125 hp at 1800 rpm, synchronous speed.

This small number of different mounting dimensions means that fewer patterns for a line of driven machines are necessary; and this, in turn, frequently lowers expense for engineering, drafting, and development.

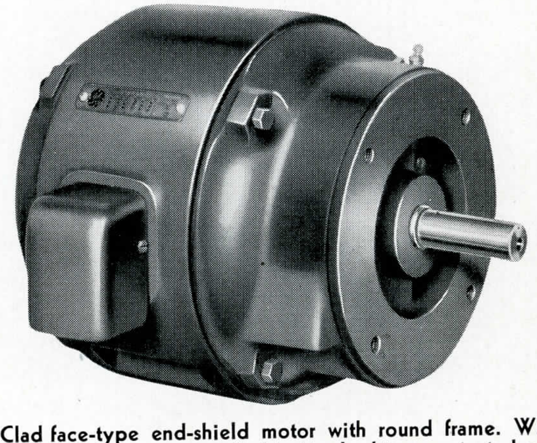
Occasionally a bolt circle or rabbet dimension other than standard is desired on the face-type end shield. For such requirements the end shield can be furnished on the motor as an unmachined casting. The casting can then be machined by the machinery manufacturer in accordance with his needs, or the work can be done by General Electric in accordance with his specifications.

3. Machine Design Is Simplified

The face-type end-shield motor can be considered as a part of the machine that is already designed and tested. General Electric engineers have done all the design work and calculating necessary to assure the dependable operation of the motor.

4. Precision Machining Assures Alignment

Because of the use of modern precision machine tools, the dimensions of Tri-Clad motors have close tolerances. Tri-Clad motor parts are carefully machined and, when assembled, form a uniform product. A right-angle relationship within close tolerances is maintained between the shaft and the machined mounting surface of the end-shield face. Modern and accurate gages are used throughout the process of assembly, assuring proper alignment when the machine is coupled to the motor.



Tri-Clad face-type end-shield motor with round frame. Where foot mounting is not required, this trim-looking, protected motor can be used to advantage for direct coupling.

Features of G-E Face-type End-shield Motors

End-shield Construction

The face-type end shield is face-machined and tapped with four holes so that a piece of equipment can be bolted against the flat face.

Enclosures Available

The *standard open motor* with face-type end shield is well protected from falling objects and dripping liquids.

The *splashproof* motor with face-type end shield has well-baffled ventilation openings, as well as insulation and conduit box particularly designed for use near splashing liquids. It can be furnished where extra protection against splashing liquids is required.

Totally enclosed and *totally enclosed fan-cooled* motors are recommended for special conditions involving operation in atmospheres containing conducting or abrasive dust, or large amounts of moisture. The face-type end shield can be furnished on either the totally enclosed, nonventilated, or on the totally enclosed, fan-cooled motors.

Explosion-proof motors are recommended for application in explosive-gas or combustible-dust locations. Various types of G-E explosion-proof motors are available which have been tested and listed by the Underwriters' Laboratories as suitable for operation in Class I, Group D, and Class II, Groups E, F, G locations as defined in the National Electric Code.

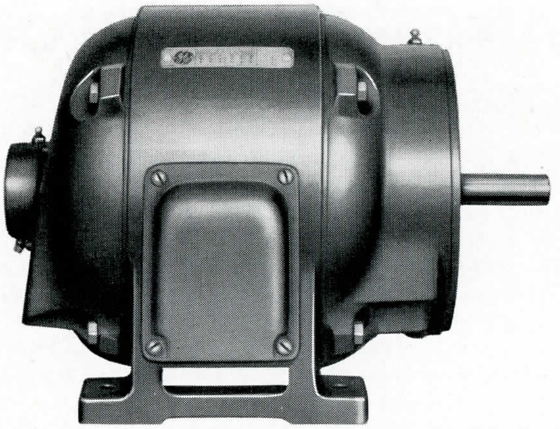
Bearings

Because end thrust is often encountered in applications involving close coupling, the face-type end shield is furnished only on the ball-bearing motor.

The bearings within the end shields are fully protected by cast-iron housings, which guard against entrance of dirt, dust, water and corrosive materials.

The bearing housing has a conveniently placed pressure-lubrication fitting, and a pressure-relief plug; hence, the bearings can be lubricated easily and without disassembly or removal from the machine.

Incoming grease is directed into the bearing by two baffles cast integrally with the end shield. Worn grease is forced down and out through the pressure-relief hole. This prevents overgreasing, which subsequently might cause overheating of the bearing.



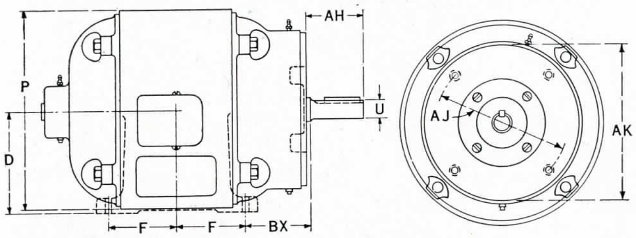
Tri-Clad face-type end-shield splashproof motor for foot mounting. The insulation, ventilation openings, and conduit box of this motor have been designed for service near splashing liquids.

Ventilation

The Tri-Clad motor has a double-end ventilating system which draws cool air over the bearings, passes it over the ends of the rotor and stator windings, and discharges it at the side. The air inlet on the face end shield is located on the motor side of the machined face and is well protected from falling dirt and dripping liquids. No openings in the driven machine are required for motor-ventilating purposes.

Since no cooling air need come from the driven machine, there are no through openings on the machined part of the end shield; thus, the solid face, when bolted to the driven machine, can be used as a tight-fitting cover plate. The bearing can be equipped with a seal which prevents oil or grease from leaking into the driven machine.

FACE-TYPE DIMENSIONS



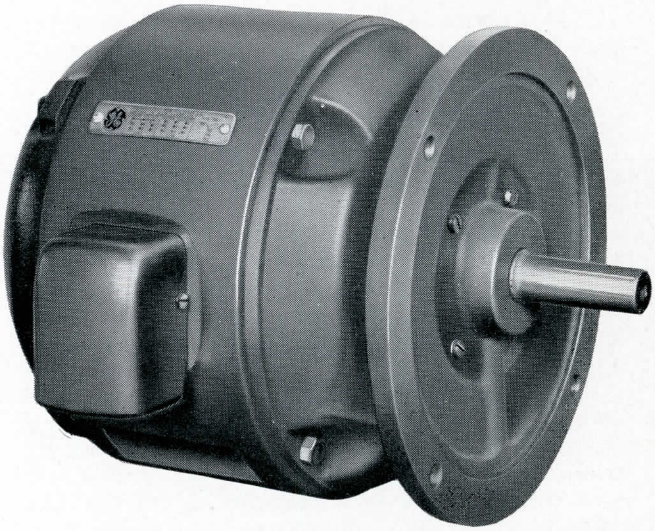
Polyphase—Single Phase—Direct Current—Open—Splashproof—Totally Enclosed
Totally Enclosed Fan-cooled (Standard and Explosion-proof)

FRAME	203	204	224	225	254	284	324	326	364	365	404	405
Dead Rise (D) (+.00 −.03)	5	5	5½	5½	6¼	7	8	8	9	9	10	10
Foot Holes (2F)	5½	6½	6¾	7½	8¼	9½	10½	12	11¼	12¼	12¼	13¾
Foot Hole to Face (BX)	3 1/16	3 1/16	3⅜	3⅜	3⅝	4 1/16	4 13/16	4 13/16	6⅛	6⅛	6⅞	6⅞
*Face to Shaft End (AH)	2 5/16	2 5/16	3⅛	3⅛	3¾	4 7/16	5 5/16	5 5/16	5⅜	5⅜	6⅛	6⅛
Shaft Diameter (U) $\left[{}^{+.0000''}_{-.0005''}\right]$	¾	¾	1	1	1⅛	1¼	1⅝	1⅝	1⅞	1⅞	2⅛	2⅙
Motor Diameter (P)	9 11/16	9 11/16	11⅛	11⅛	12⅝	14⅛	15¾	15¾	17⅛	17⅛	19⅜	19⅜
Bolt-circle Diameter (AJ)	7¼	7¼	7¼	7¼	7¼	9	9	9	11	11	11	11
Rabbet (Male) Diameter (AK) $\left[{}^{+.000''}_{-.003''}\right]$	8½	8½	8½	8½	8½	10½	10½	10½	12½	12½	12½	12½
Bolt-hole Diameter	½″ #13 tap								⅝″ #11 tap			

* Bearing nose projects beyond face on 203 and 204 frames only—1/16″.
Preliminary Dimensions—Do not use for construction.

FLANGE*-TYPE MOTORS—Use Them Where the Machine Supports the Motor

Flange-type end-shield motors are best suited for use with driven machines large enough to support the motor because the end shield of this type is designed for attaching by through bolts tightened from the motor side of the end-shield mounting surface. (For this reason, a motor with a flange-type end shield is frequently furnished with a round frame, without feet; however, the motor can be furnished with feet if so desired.)



Tri-Clad round-frame motor with Type B flange end shield. The round-frame motor is usually used when the driven machine will support the motor.

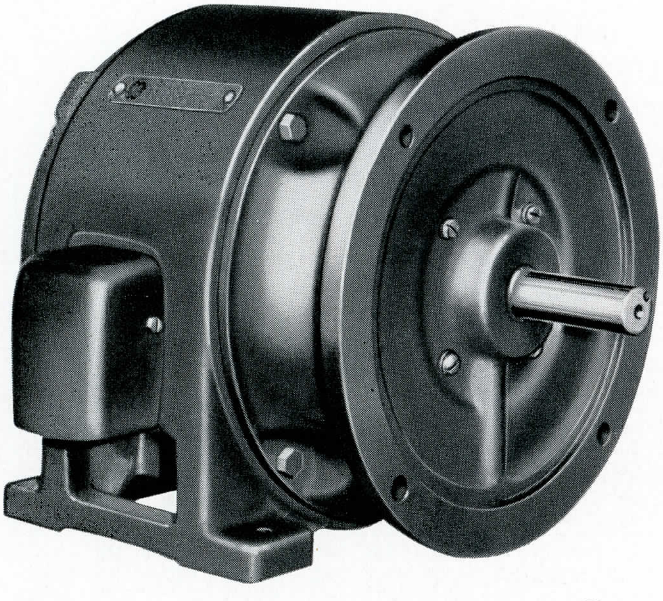
Assembly Costs Are Reduced

As with the face-type end-shield mounting, the use of a flange end shield materially cuts assembly costs because the motor is complete—ready to run before being mounted; assembly consists merely of bolting the motor to the machine.

Simplification of Design

In modern machine equipment there is a trend toward direct motor drive. It is desirable that the shaft of the direct-driven machine be coupled as closely as possible to the rotor of the driving motor. The closest coupling, of course, involves mounting the rotor on the machine shaft. But while this is often advantageous, there must be taken into account the ventilation of the motor, the machining of the shaft, the pressing of the rotor onto the shaft, and the selection of the bearings and making provision for greasing them.

On the other hand, a flange-type Tri-Clad motor can be bolted to a machine, in close proximity to its drive shaft, to provide a neat, compact, efficient direct-drive unit without raising problems of ventilation, bearing, and alignment. The length and machining of the motor-shaft extension can be specified if desired.



Tri-Clad motor with Type B flange end shield and feet. These flange-end-shield motors, with or without feet, are easy to couple directly to the driven machine.

Protection Is Essential

Direct-coupled motors are often located where they are subjected to falling chips and shavings, making it essential that they be well protected. The Tri-Clad motor with flange end shield is an excellent unit for such applications because the mechanical design of the frame structure protects vital motor parts from lubricants and coolants, chips, shavings, and the like.

In locations where the motor will be subjected to splashing or spray liquids, increased protection can be obtained by using the Tri-Clad splashproof motor with flange end shield.

For applications involving atmospheres of abrasive or conducting dust, high humidity, or explosive gases, a totally enclosed or explosion-proof motor is recommended.

Standardization

The mounting dimensions of the Type B flange have been standardized in accordance with Paragraph MG4-21.5, Standards of the National Electrical Manufacturers Association. Thus the machine builder is assured of interchangeability of motors.

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* *Type B flange, with mounting dimensions standardized by NEMA*

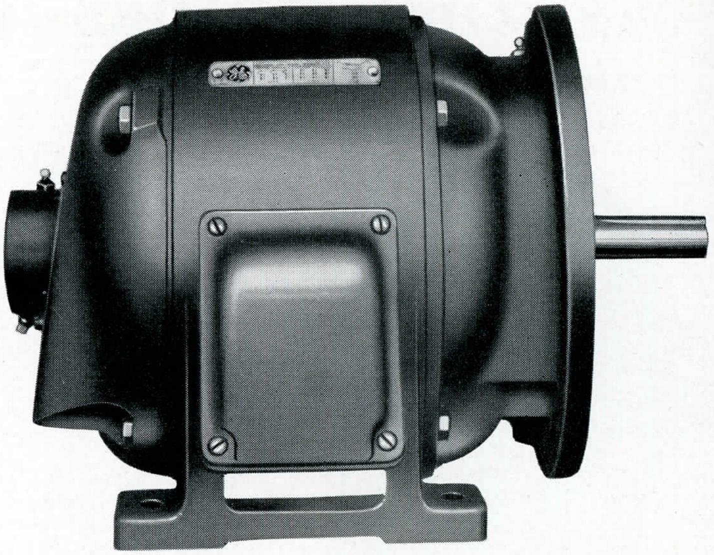
Mounting Dimensions Are Interchangeable

The mounting dimensions of the Type B flange are used for many different motors. The same type of flange, with the same dimensions, can be furnished with open, splashproof, totally enclosed (fan-cooled or nonventilated), explosion-proof, also wound-rotor induction motors and with many different ratings of direct-current motors. Flanges for all these mechanical and electrical constructions have the same standardized series of mounting dimensions.

The number of different mounting dimensions has thus been kept low. Only four sets of flange dimensions are required for frame sizes 203 to 445 (1 hp to 75 hp at 1800 rpm) for induction motors; and only two sets for frame sizes 203 to 284, both inclusive; 66, and 67 (1 hp to 15 hp at 1750 rpm) for direct-current motors. For ratings between 1 hp and 15 hp at 1800 rpm, the flange dimensions are exactly the same for both induction motors and direct-current motors. This means that a machine, with no mechanical modification, can be installed in territory serviced by either a-c (single-phase or polyphase) or d-c.

Ventilation

The ventilation of the Tri-Clad motor with Type B flange end shield is similar to that of the motor with face-type end shield in that the ventilating air is brought in through openings at the bottom of the end shield. No provision need be made by the machine designer to provide ventilating air through the machine. Advantage can be taken of the solid face of the end shield and its accurate machining by using it as an oil-retaining cap on the machine housing for the normal condition where the oil level is below the shaft.



Tri-Clad splashproof motor with Type B flange end shield and feet, for use in wet surroundings where splashing liquids and spray are present.

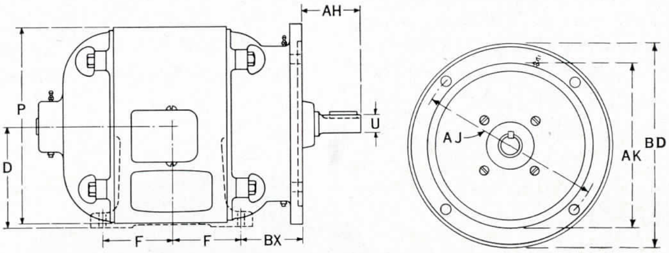
Bearings Are Protectively Enclosed

All flange-mounted motors are of the ball-bearing type, for experience has shown this type of bearing to be best suited for close-coupled applications where the thrust of pinion drives or tilted operation is commonly encountered.

The ball bearings within the end shields are protected by complete cast-iron enclosures which guard against the entrance of dirt and other foreign materials.

Lubrication is facilitated by a pressure-lubricating fitting and a pressure-relief plug conveniently located on the motor side of the flange.

FLANGE-TYPE (TYPE B) DIMENSIONS

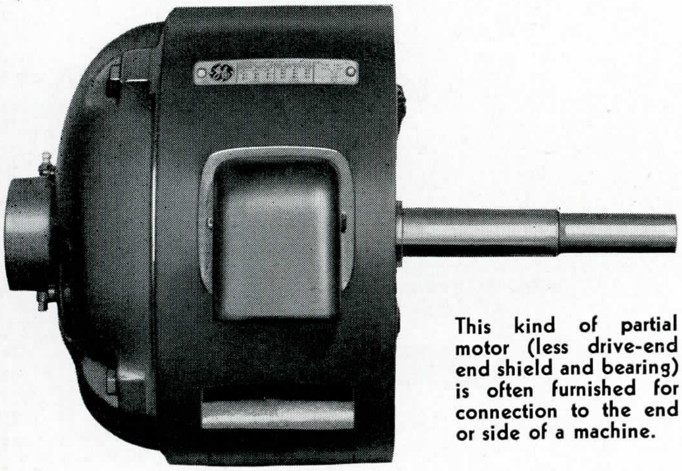


Preliminary dimensions—do not use for construction. Figure shows polyphase open motor only; contour varies for other constructions.

Polyphase—Single Phase—Direct Current
Open—Splashproof—Totally Enclosed—Totally Enclosed Fan-cooled (Standard and Explosion-proof)

FRAME	203	204	224	225	254	284	324	326	364	365	404	405
Dead Rise (D) (−.00 −.03″)	5	5	5½	5½	6¼	7	8	8	9	9	10	10
Foot Holes (2F)	5½	6½	6¾	7½	8¼	9½	10½	12	11¼	12¼	12¼	13¾
Foot Hole to Face (BX)	2¾	2¾	3 1/16	3 1/16	3 9/16	3 13/16	4 5/16	4 5/16	6⅛	6⅛	6⅞	6⅞
Face to Shaft End (AH)	2⅝	2⅝	3 7/16	3 7/16	4 1/16	4 11/16	5 13/16	5 13/16	6¾	6¾	8¼	8¼
Shaft Diameter (U) (+.0000 −.0005″)	¾	¾	1	1	1⅛	1¼	1⅝	1⅝	1⅞	1⅞	2⅛	2⅛
Motor Diameter (P)	9 11/16	9 11/16	11⅛	11⅛	12⅝	14⅛	15¾	15¾	17⅛	17⅛	19⅜	19⅜
Bolt-circle Diameter (AJ)	10	10	10	10	10	12½	12½	12½	16	16	16	16
Rabbet (Female) Diam. (AK) $\left[\begin{smallmatrix}+.003''\\-.000''\end{smallmatrix}\right]$	9	9	9	9	9	11	11	11	14	14	14	14
Flange Diameter (BD)	11	11	11	11	11	14	14	14	18	18	18	18
Bolt-hole Diameter (BF)	17/32	17/32	17/32	17/32	17/32	13/16	13/16	13/16	1	1	1	1

PARTIAL MOTORS—Use Them for Direct Coupling in a Restricted Space



This kind of partial motor (less drive-end end shield and bearing) is often furnished for connection to the end or side of a machine.

Over-all symmetry, space limitations, bearing arrangement, necessity for very compact, simple, and efficient drive or similar factors may sometimes dictate the use of partial motors.

A complete motor is one made up of a stator, a rotor, a shaft, and two end shields with bearings. A partial motor, on the other hand, is supplied less one or more of these parts.

While the partial motor can be furnished in many forms (a complete motor less one or both end shields, less shaft, or less end shields and shaft), it is usually furnished in one of the two forms illustrated. For applications in which the partial motor is to be connected to the end or side of a driven machine, the motor is commonly furnished less drive-end end shield and bearing. Where it is essential that a partial motor be built into the machine, a motor less shaft, both end shields, and bearings might well be used.

Application of Partial Motors

The motor without drive-end end shield and bearing should be mounted to the end or side of the driven equipment. Since the machine itself substitutes for the drive-end end shield, a reduction of over-all length may be gained.

A motor mounted directly to the head-stock of a lathe is a good example of how a motor without a pulley-end end shield can be applied to minimize over-all machine length. This construction is equally well suited for use with small hoists, gear reducers, and similar machines.

A motor less both end shields and shaft lends itself well to built-in applications—such as multiple-drilling machines, precision grinders, deep-well pumps, compressors, and hoists—where the rotor actually is made a part of the driven machine.

Limitations

While partial motors are, in many respects, ideal for close coupling and built-in applications, their use involves some problems not encountered when the complete motor is used.

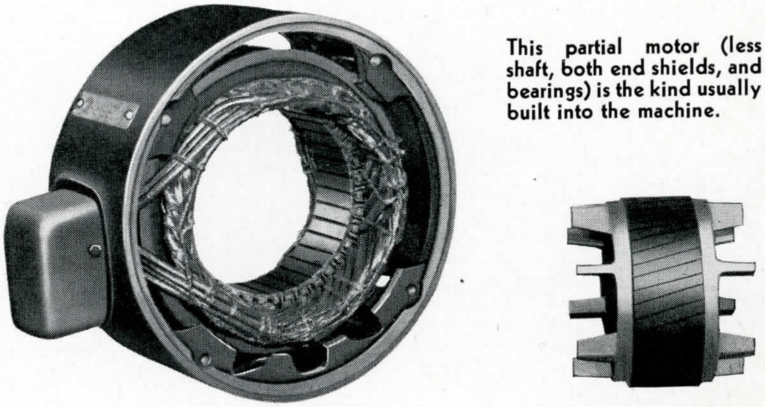
Since only part of such a motor is furnished by General Electric, proper ventilation, mounting, alignment and bearings obviously must be arranged for by the machine designer. This is especially important when stators and rotors only are to be used.

1. Ventilation

In order that the temperature rise of the motor shall not exceed the nameplate rating, care must be taken to see that the motor is properly ventilated. An adequate volume of cooling air must be drawn over the ends of the stator and rotor windings; this air should not have an ambient temperature in excess of 40 C unless special motor insulation, light or intermittent loading, water cooling, or similar factors are involved.

The double-end ventilation of the Tri-Clad motor is designed to provide uniform cooling. The fan blades on each end of the rotor draw the cooling air in over the bearings, pass it over the ends of the stator and rotor windings, and discharge it through openings in the bottom part of the frame.

The rotor fan blades are designed to circulate ample air for cooling, provided the ambient temperature is less than 40 C, and provided the air-inlet



This partial motor (less shaft, both end shields, and bearings) is the kind usually built into the machine.

passages are sufficiently large and properly located.

The drawings on this page show the air-passage dimensions that will provide for ample cooling air.

2. Mounting

The outline drawings show dimensions, tolerances, and clearances necessary for properly mounting the motor to your machine.

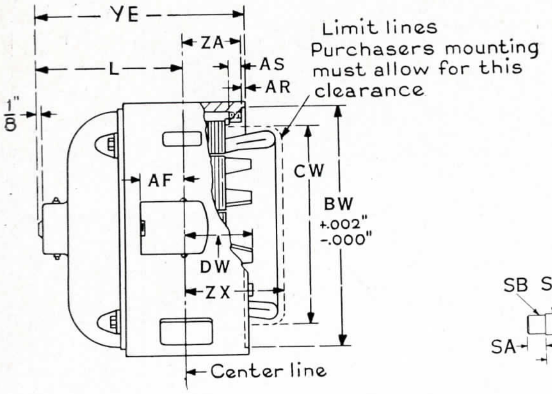
3. Bearings and Lubrication

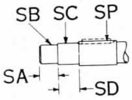
Suitable bearings and provision for lubrication must be provided by the machine designer.

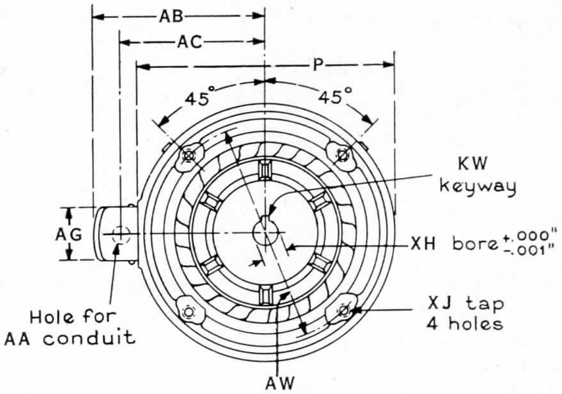
The bearing manufacturer should be consulted for help in applying the bearings.

Because partial motors are usually built into the driven machine, they may not be readily accessible. Therefore, it is very important that proper bearings be selected, that the design of the machine allows for adequate cleaning and flushing of the bearings, and that the bearings be well protected against the entrance of dirt and grit. Furthermore, no oil or grease from the bearings should be allowed to get to the motor windings. However, provision should be made for dismantling the motor with reasonable speed. If operating conditions are particularly severe, and only a short time for making repairs is permissible, a motor with a face or flange mounting is recommended instead of a partial motor.

Approximate Dimensions in Inches—Tri-Clad Open Partial Motors







Approximate dimensions in inches.

FRAME	YE Approx	L	P	AA	AB	AC	AF	AG	AR Approx	AS	AW	BW	CW	DW	SB	SC	SP	Air Entr Area In²	KW	SA	SD	XH	XJ	ZA	ZX
203	8 9/32	5⅞	9 11/16	¾	7 1/16	6	2 3/16	2⅞	5/32	½	8½	9.187	6⅞	2 9/32	.9847	1.320	1.328	9.9	—	1 55/64	1⅞	1.325	5/16–18	2¼	3 9/16
204	9 9/32	6⅜	9 11/16	¾	7 1/16	6	2 3/16	2⅞	5/32	½	8½	9.187	6⅞	2 9/16	.9847	1.320	1.328	9.9	—	1 55/64	1⅞	1.325	5/16–18	2¾	4⅛
224	9⅝	6⅞	11⅛	¾	7¾	6 11/16	2 3/16	2⅞	3/16	9/16	9⅞	10.625	8¼	2½	1.1815	1.555	1.565	12.8	—	2 3/64	1⅞	1.562	⅜–16	2 9/16	4 1/16
225	10⅜	7¼	11⅛	¾	7¾	6 11/16	2 3/16	2⅞	3/16	9/16	9⅞	10.625	8¼	2⅞	1.1815	1.555	1.565	12.8	—	2 3/64	1⅞	1.562	⅜–16	2 15/16	4 7/16
254	11½	8 5/16	12⅝	1	8 15/16	7⅝	2⅝	3¼	3/16	9/16	11⅛	12.000	9⅛	3 5/32	1.3784	1.805	1.815	14.8	¼x 9/64	2 35/64	2 15/16	1.812	⅜–16	3	4 11/16
284	12 15/16	9 7/16	14⅛	1	9 11/16	8⅜	2⅝	3¼	3/16	11/16	12⅜	13.500	10¼	3 19/32	1.5752	2.040	2.050	22.0	¼x 9/64	2 35/64	3 11/16	2.047	⅜–16	3 5/16	5¼
324	14 7/16	10 7/16	15¾	1¼	11 11/16	9⅝	3¾	4	¼	¾	13⅞	15.000	11⅜	4¼	1.7721	2.290	2.300	30.0	⅜x 13/64	2 47/64	4 29/32	2.297	½–13	3¾	6 1/16
326	15 15/16	11 3/16	15¾	1½	11 11/16	9⅝	3¾	4	¼	¾	13⅞	15.000	11⅜	4¾	1.7721	2.290	2.300	30.0	⅜x 13/64	2 47/61	4 21/32	2.297	½–13	4½	8 1/16
364	15¾	11¼	16½	2	13	10⅞	5		3/16		15	15.750		5⅛				20.0				2.625	½–13		8
365	16¾	11¾	16½	2	14⅜	12¼	5		3/16		15	15.750		5⅞				20.0				2.625	½–13		8½
404	17 7/16	12 7/16	19	3	16⅛	13⅛	6¼		3/16		17 5/16	18.125		6½				24.0				2.875	½–13		8⅛
405	18 15/16	13 3/16	19	3	17⅜	14¼	6¼		3/16		17 5/16	18.125		7⅛				24.0				2.875	½–13		9½

FRACTIONAL-HP MOTORS—Use Them for Every Small-motor Duty

Where machine-tool and industrial motors of fractional-horsepower ratings are required for direct coupling, the types illustrated on this page are recommended.

These motors, furnished in ratings ¼, ⅓, ½, and ¾ hp at 1725 rpm, have been designed especially to meet the severe requirements resulting from direct coupling to machine tools, small pumps and compressors, and similar equipment.

Construction Features

End Shields

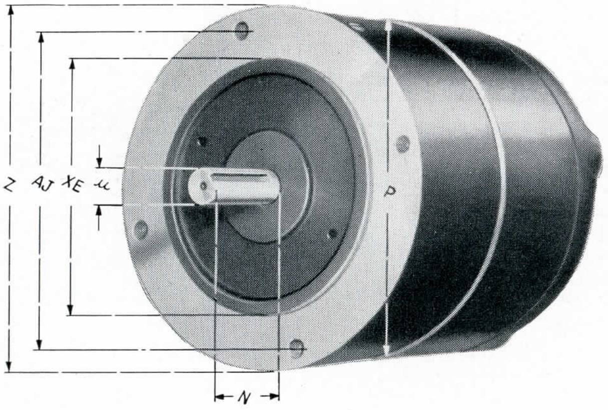
The end shields are totally enclosed with an enclosed conduit box built into the end shield opposite the drive end. This construction results in a compact motor that is completely protected against the entrance of abrasive dust, chips, and cutting compounds.

Because, with direct-coupled applications, end thrust is often encountered, ball-bearing assemblies are used. The bearings are packed with sufficient grease at the factory to provide lubrication for two years of normal service.

The motors can be mounted horizontally, vertically, or at any angle.

Rotor

The rotor has a one-piece, cast-aluminum winding assuring permanent electrical characteristics and exceptional rigidity.

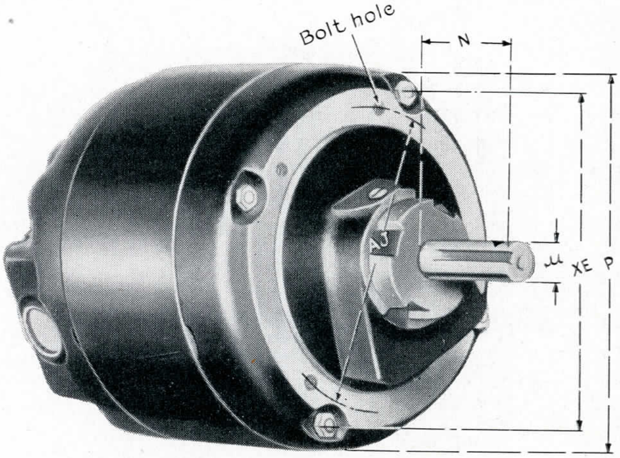


Style F-2—Flat-face end shield, NEMA standard dimensions.

FRAME	U	N	AJ	XE	P	BOLT HOLE	Z
40	⅝*	1 15/16*	5⅞	4.500	6 5/16	⅜″ 16 tap	6½
60	¾	2 5/16	5⅞	4.500	7½	⅜″ 16 tap	6½
70	¾	2 5/16	5⅞	4.500	8 7/16	⅜″ 16 tap	6½

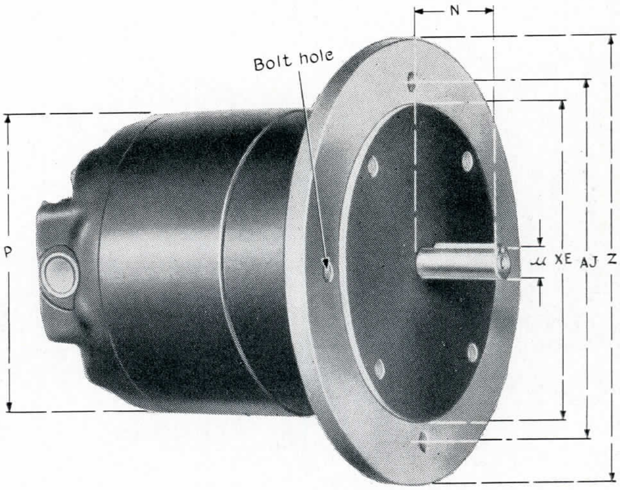
Stator

The stator is wound with Formex wire and is thoroughly bonded and rigidly held to withstand the stresses of starting, stopping, and plugging duty.



Style F-1—Machined-rabbet end shield, extended bearing hub.

FRAME	U	N	AJ	XE	P	BOLT HOLE ‡
20	⅜	1¼	2 11/16	2.187	4⅝	#10–32 tap ⅜″ deep
40	⅝*	1 15/16*	4 13/16	4.250	6 5/16	5/16″ 18 tap
60	¾	2 5/16	5¾	5.000	7½	⅜″ 16 tap
70	¾	2 5/16	5¾	5.000	8 7/16	⅜″ 16 tap



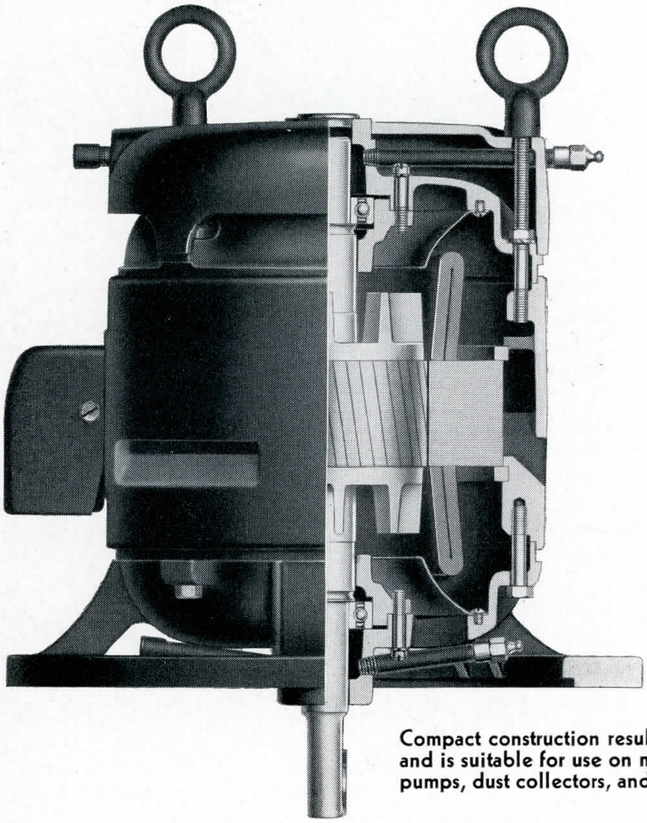
Style F-3—Flange-type end shield.

FRAME	U	N	AJ	XE	P	BOLT HOLE (on 45°)	Z
40	⅝*	1 15/16*	8½	6.500	6 5/16	7/16″	9½
60	¾	2 5/16	8½	6.500	8 7/16	7/16″	9½
70	¾	2 5/16	8¾	6.500	8 7/16	7/16″	9½

* The following have ½″ diameter shaft 1 9/16″ long:
2 pole, ¼ hp
4 pole, ⅛, ⅙ hp
6 pole, 1/12, ⅛ hp
8 pole, 1/20 hp.

‡ Upper holes 30° from vertical.
Lower holes 30° from horizontal.

VERTICAL MOTORS—Use them for Direct Coupling to Vertical Shafts



Conveniently located eyebolts make it easy to handle this vertical motor.

The roomy conduit box can be opened by removing only two screws. The opening in the conduit box can be turned to any one of four positions.

The variety of bases available makes it possible for this motor to meet a great many applications and mounting requirements.

Many horsepower and speed combinations are interchangeable because several of the ratings have the same base dimensions.

All holes are jig-drilled for accurate mounting.

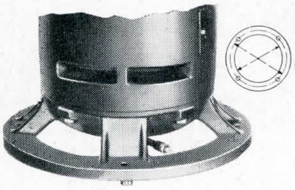
The bolt holes are equally spaced around the base to permit locating the conduit box in any of four positions with regard to the driven machine.

The weight and thrust of rotating parts are directly transmitted to the supporting base.

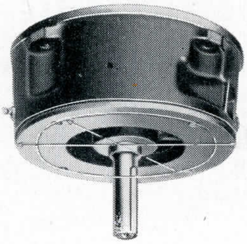
Permanent alignment is assured by accurately machined rabbets in the stator frame and base.

Compact construction results in a motor that fits into small space and is suitable for use on metal- and wood-working tools, indoor pumps, dust collectors, and other plant equipment.

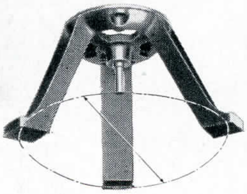
CHOOSE THE BASE YOU WANT FOR YOUR PARTICULAR JOB



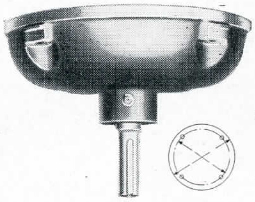
Ring Base



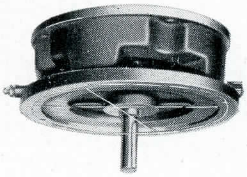
Face Base



Tripod Base



End-shield-mounting Base



NEMA Type B Flange Base

Dimensions of Bases in Inches

	Standard Ring Base					Face Base					Tripod Base					End-shield-mounting Base					NEMA Type B Flange Base				
Frames	203 204	224 225	254	284	324 326	203 204	224 225	254	284	324 326	203 204	224 225	254	284	324 326	203 204	224 225	254	284	324 326	203 204	224 225	254	284	324 326
Bolt Circle	12½	12½	12½	16	16	7¼	7¼	7¼	9	9	18¾	18¾	18¾	22	22	8½	9⅞	11⅛	12⅜	13⅞	10	10	10	12½	12½
Rabbet (female)	11	11	11	14	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	9	9	11	11
Rabbet (male)	—	—	—	—	—	8½	8½	8½	10½	10½	—	—	—	—	—	9 3/16	10⅝	12	13½	15	—	—	—	—	—

SHELL-TYPE MOTORS—Use Them for High-speed, Built-in Applications

Shell-type induction motors are often used for high-speed drives and also are suitable for any application requiring a built-in motor that is smooth, streamlined, and has close shaft or bearing centers.

Such applications include boring machines, multiple-spindle drilling machines, high-speed grinders and saws, and wood-carving machines.

The motor consists essentially of a shaftless rotor (Fig. 1) and a shell-like cylinder that carries the stator punchings and windings. The outside surface of the cylinder is ground to a very close diametral tolerance so that it will fit snugly in the housing in which the motor is to be mounted.

As with other partial motors, of which the shell-type is a particular kind for special applications, ventilation, bearings and lubrication, final balance, proper assembly and accessibility need consideration by the machine designer.

Advantages

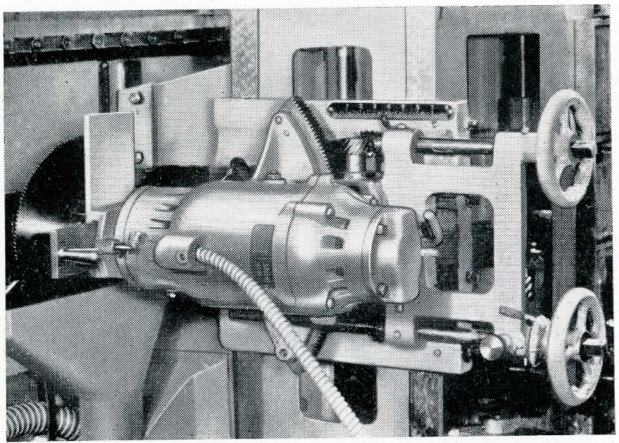
1. Compactness

Shell-type induction motors contribute to the compactness of a machine because diameters are kept small by an increase in the length. This permits machine shafts or spindles to be designed with close centers.

2. High Speeds

Because these motors can be operated at very high speeds, a relatively high horsepower rating can be built into a small space.

The usual frame-type induction motor is operated at speeds of 3600 rpm and lower, although it can be specially designed to operate at higher speeds with high-frequency supply.



A G-E shell-type motor was specified for this double-end tenoner because of limited space requirements.

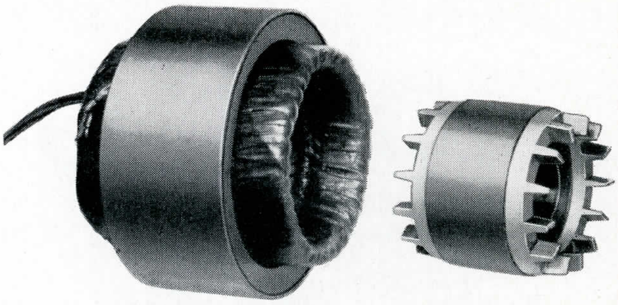


Fig. 1

Some applications, however, such as grinders, woodcarvers, dessicators, and routers, require considerably higher motor speeds. Because the rotor of the shell-type induction motor has a relatively small diameter, it is inherently suitable for operation at speeds much higher than 3600 rpm. By using an induction frequency converter, or another high-frequency set, it is possible to supply these motors with frequencies up to 540 cycles (and even higher) to give synchronous speeds up to 32,400 rpm (or higher).

3. Rapid Reversing

Some machines, such as screw machines, tapping machines, and lathes, require rapid reversing motors. The more reversals per minute the motor can stand, the greater the production of the machine.

Reversing electrically instead of mechanically results in a cushioning effect which reduces wear on the machine as a whole.

The capacity of a motor to reverse a certain number of times in a given period is a function of the rotor inertia plus the external connected inertia. A built-in motor, such as the shell type, connected directly and reversed electrically, may permit more reversals per minute than would a conventional motor with connecting links having inertia.

4. Standardization

Dimensions of shell type motors have been standardized for three diameters by the National Electrical Manufacturers Association. These diameters are 8 inches, 10 inches, and 12.375 inches, and include ratings of 1½ hp to 25 hp at 3600 rpm.

These standardized dimensions assure interchangeability of motors of various manufacturers, and make for flexibility and convenience in applying the motors to machines.

Other motors with diameters as low as 4.703 inches are also available. Dimensions for these motors have not been standardized, but are, nevertheless, widely used. They are: 4.703, 5.703, 6.468 inches.

Application Information

A shell-type motor consists only of stator and rotor; the user must furnish the shaft and the bearings and provide for assembly, balance, and ventilation. For proper operation of this type of motor, careful attention must be paid to these factors:

1. Mounting and Accessibility

The machine designer must arrange for the proper mounting of the stator shell and of shaft and bearings for the rotor.

A uniform air gap is essential for uniform torque, good characteristics, and quietness. The machine designer must provide for close tolerances in the dimensions of the shaft, bearing housing, rabbet on the end shield, and housing bore. All of these tolerances and fits should limit the air-gap variation to not more than 10 per cent.

The shaft diameter should be adequate to handle the torque to be transmitted, with the least possible torsional vibration and deflection. Generally speaking, the standard bore of the rotor is of sufficient diameter to take a shaft which will safely transmit the torque of the motor. In certain instances of overhanging loads, heavy radial pressure, or high-inertia starting, a larger shaft may be required.

Tabulated dimensions on the next page show over-all motor length and the standard rotor bore of shell-type motors.

It is especially important that the machine be so designed that the driving motor is accessible and can be easily dismantled in case of an emergency.

2. Balance

Because shell-type motors are generally used at high speed, good dynamic balance is of critical importance. Rotors, as furnished, are accurately balanced; but after the user has mounted the rotor on the shaft and installed the bearings, careful balancing is important.

Clamping a rotor on the shaft may introduce internal stresses and unbalance unless the clamping washer and rotor face plate fit perfectly. Although the clamping method of mounting is more convenient, a press fit is recommended.

Balancing may be accomplished by adding or removing material from the rotor assembly; but material should never be removed from rotor end rings because these rings are designed to give certain electrical characteristics, and any change in ring cross section affects these characteristics.

According to recommended balancing practice, balancing rings are so mounted on the shaft that material can be added to or removed from them. It is suggested that the rings be incorporated as part of the ventilating fans mounted on the shaft.

3. Ventilation

The machine designer must design proper ventilation of the shell-type motor so that the motor will operate at its temperature rating. But G-E engineers are in a position to make specific recommendations as to methods of ventilation for special applications. By submitting your motor-housing problem to these engineers, you will be assured of the benefit of G-E engineers' years of experience in applying shell-type motors.

Suggested Methods of Ventilation

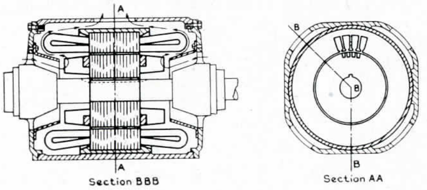
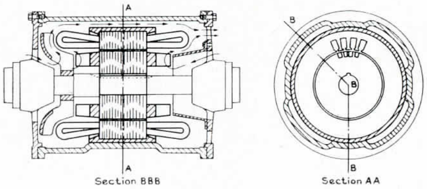


Fig. 2
Open, double-end ventilated

Fig. 3
Open, single-end ventilated, with one shaft-mounted auxiliary fan



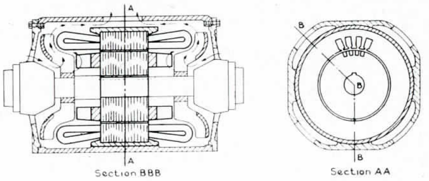
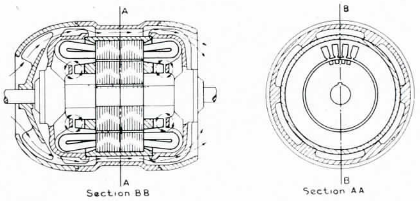


Fig. 4
Open, double-end ventilated, with two shaft-mounted auxiliary fans

Fig. 5
Totally enclosed, fan-cooled, single-end ventilated, with one shaft-mounted external fan

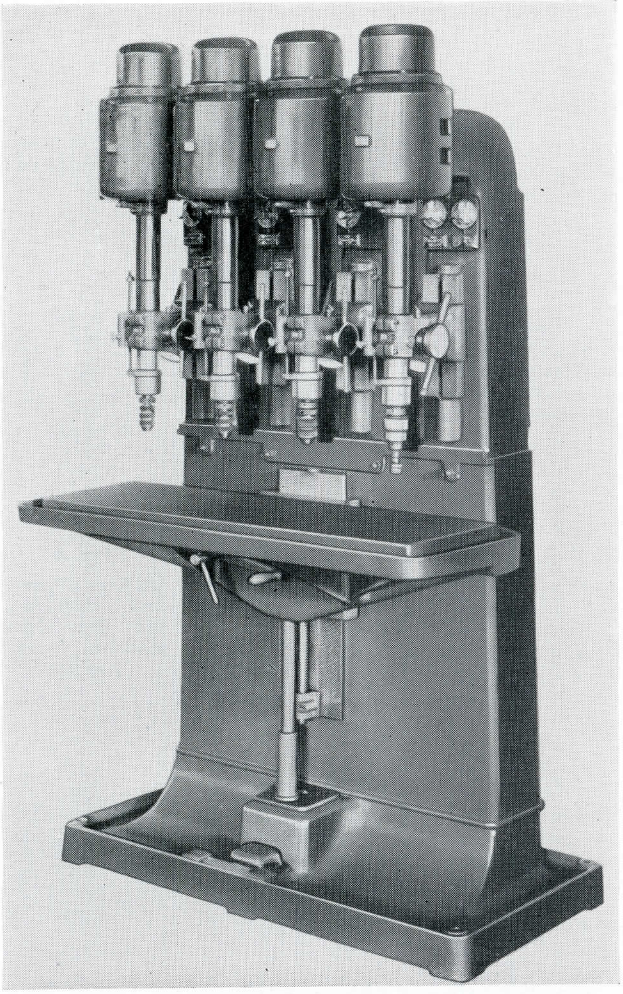


The shaded portion of each figure indicates the parts supplied by the G.E. Company, consisting of stator and rotor only. Light lines represent parts to be provided by the purchaser.

However, there are a few basic facts set down in this bulletin which can be used as a guide. On this page are diagrams showing suggested methods of ventilation. Fig. 2 shows a housing arranged for open, double-end ventilation. No auxiliary fans are used—air is caused to circulate by means of blades cast integrally with the rotor winding. This type of ventilation is generally suitable only for a motor with a relatively short length of shell.

Fig. 3 shows an open-motor construction arrangement with an auxiliary fan at one end to give adequate cooling for medium-length motors.

Fig. 4 shows the housing arranged for open, double-end ventilation, with two shaft-mounted auxiliary fans. This is the best method of ventila-



Each spindle of this multiple-spindle drill press is driven by a built-in direct-connected shell-type motor.

tion and is suitable for use with motors of long shell length.

Sometimes the presence of excessive moisture, dirt, or dust makes it necessary to enclose the motor fully. Ventilation then becomes more complicated, but Fig. 5 shows a suggested arrangement for single-end ventilation (with one shaft-mounted external fan) of totally enclosed, fan-cooled motors.

A totally enclosed, nonventilated housing could be used particularly if the motor is to be in close contact with a great mass of conducting metal; but it is generally not recommended, because the inability of the usual mounting to carry away the internally generated heat necessitates de-rating the motor considerably.

In designing the fans, care should be taken to provide ample cooling air for the motor. The rule of thumb states that at least 10 to 15 cubic feet of free air per minute per horsepower output of the motor should be supplied. The lower figure is satisfactory for ratings above 5 hp, while lower ratings require the higher figure.

4. Bearings and Lubrication

Shell-type motors are used for such a variety of applications that no hard and fast recommendation can be made for bearing design. Ball bearings are generally used with shell-type motor applications, and bearing manufacturers maintain excellent engineering departments, which will gladly co-operate with the machine designer in selecting the best type of bearing for his job.

Provision should be made in the design for the adequate cleaning and flushing of bearings. Care should be taken that no oil or grease enters the motor, where it might harm the windings.

RATINGS AND PRINCIPAL DIMENSIONS OF SHELL-TYPE MOTORS

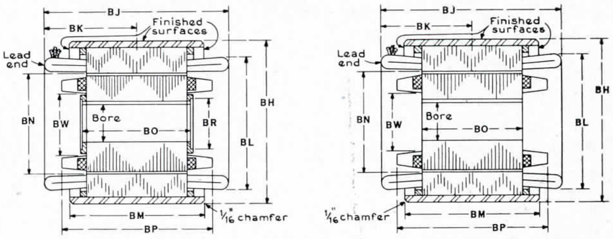


Fig. 1

Rotor with end plates **Rotor without end plates**

Continuous Hp Ratings				Available Frames			Shell Length BM	Standard Bore Dimensions	Keyway
Rpm				Frame Number	Diameter BH	Over-all Maximum Length BJ			
3600	1800	1200	900						
⅓	Can be furnished to meet requirements			12	4.703	4¾	1 31/32	1.000	3/16
½				15	4.703	5½	2 23/32	1.000	3/16
¾				16	4.703	6¼	3 15/32	1.000	3/16
1				17	4.703	7	4 7/32	1.000	3/16
1				28	5.703	6½	3 7/32	1.25	¼
1½				29	5.703	8	4 23/32	1.25	¼
2				29¾	5.703	11¾	8 15/32	1.25	¼
2				37	6.468	8⅛	4 11/32	1.5	⅜
3				38	6.468	8½	4 23/32	1.5	⅜
5				39	6.468	10	6 7/32	1.5	⅜
7½				39Y	6.468	11½	7 23/32	1.5	⅜
← NEMA STANDARD →									
1½	1	¾	—	3410	8.000	6¼	2⅞	1.5	⅜
2	1½	1	½	3420	8.000	7	3⅝	1.5	⅜
3	2	1½	¾	3430	8.000	7⅝	4⅛	1.5	⅜
5	3	2	1	3440	8.000	8⅝	5⅛	1.5	⅜
7½	5	3	1½	3450	8.000	10⅛	6⅝	1.5	⅜
10	7½	5	2	3460	8.000	11⅝	8⅛	1.5	⅜
7½	5	3	2	3540	10.000	8¾	4⅝	1.875	⅜
10	7½	5	3	3550	10.000	10	5⅞	1.875	⅜
15	10	7½	5	3560	10.000	12¾	8⅝	1.875	⅜
20	15	10	7½	3570	10.000	15¼	11⅛	1.875	⅜
15	10	7½	5	3640	12.375	10¼	5⅛	2.25	½
20	15	10	7½	3650	12.375	12¼	7⅛	2.25	½
25	20	15	10	3660	12.375	14¼	9⅛	2.25	½
30	25	—	—	3670	12.375	16¼	11⅛	2.25	½

THREE EASY AND PRACTICAL WAYS TO DETERMINE WR^2

The moment of inertia of a driven load is of extreme importance in properly selecting motors which accelerate heavy loads or make frequent starts—such as motors for rapid reversing service, extractors, tapping machines, etc. Its determination is not difficult, but is often neglected because of lack of familiarity with a suitable method.

In engineering work the moment of inertia is expressed as WR^2 in terms of pound-feet squared. These units then are commensurate with the other engineering units of pounds, feet, horsepower, etc.

It can be determined in three ways, (1) by calculation (that need not be too precise to be useful), (2) by measured comparison to an easily computed object, and (3) by direct measurement. Instructions for each of these methods are given below.

Calculations of WR^2

WR^2 is the product of the weight of an object and the square of the radius of gyration, or $WR^2 = Wk^2$; where W it is the weight of object in lbs, and k is the radius of gyration in feet (radius of gyration can be considered an average of the radii from the axis of rotation to each infinitesimal part of the object).

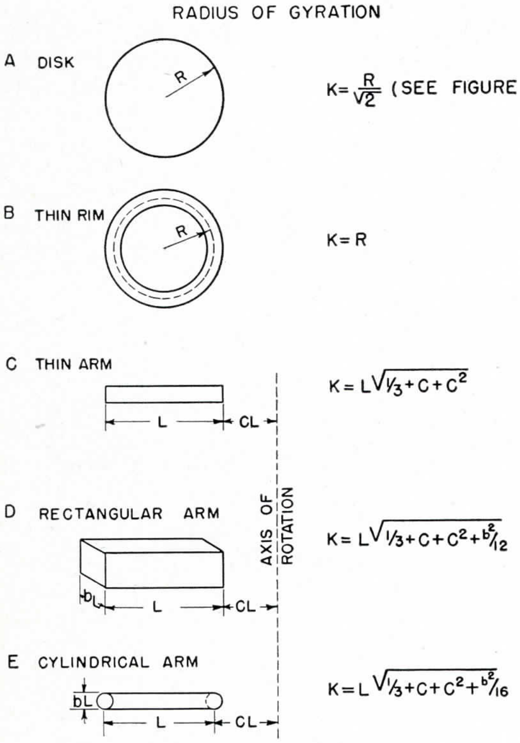


Fig. 1. Radius of Gyration

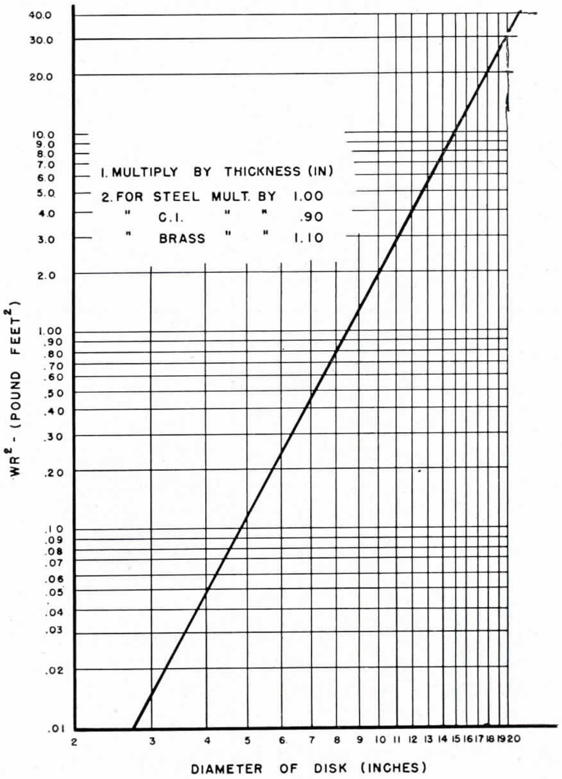


Fig. 2. WR^2 of Solid Disks

The calculation of a relatively complicated object can readily be made by breaking it up into its simple components, easy to calculate in themselves. Most rotating objects can be broken down to a series of rims, spokes and disks.

Radius of Gyration

Since the WR^2 add to each other directly, each segregated unit can be calculated and the results added to obtain the total.

Figure 1 shows the three basic components and their radii of gyration, k. Figure 2 shows the WR^2 of solid disks. This chart can be used to determine the WR^2 of thick rims by subtracting the WR^2 of an imaginary disk of the inside diameter from that of a disk of the outside diameter. As an example, the calculation of the WR^2 of the flywheel in Figure 3 is shown. The computation is best carried on in tabular form, Fig. 4.

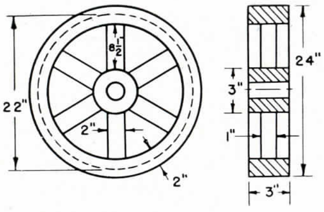
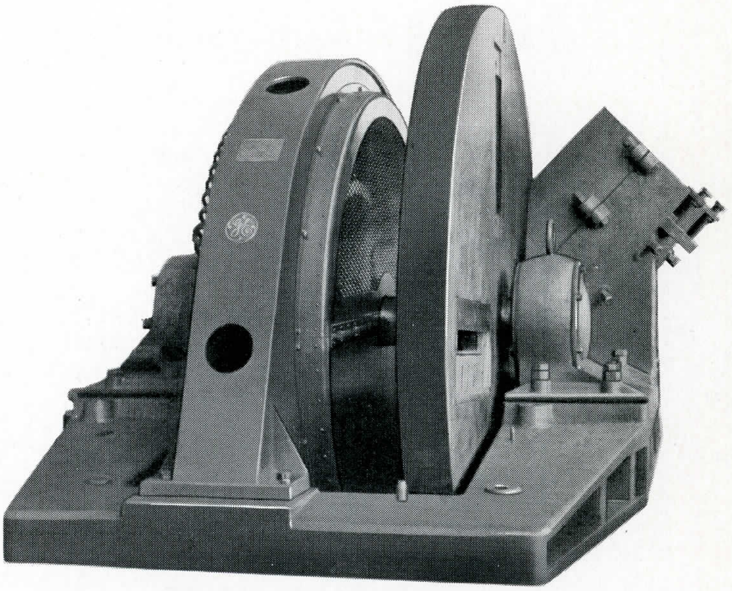


Fig. 3. Flywheel

Part	Volume (Cu In.)	Weight (Lbs)	(In.)	WR² (Lb. in. squared)
Rim	415	106	11	12,800
6 spokes	103	26	6.2	1,000
Hub	21	5	1.0	5
				13,805

Fig 4. WR^2 (lb ft squared) $= \frac{13{,}805}{144} = 96.2$



Motors for wood-chipper drives must be selected carefully because of the tremendous initial load imposed on the motor in bringing the chipper up to speed.

It can be noted that the major part is in the rim and that only this need be calculated, even for a comparatively close approximation.

WR^2 Measurement by Comparison

This method consists of suspending the object to be measured from a wire, giving it a twist and recording the time for a given number of complete torsional oscillations. A disk of about the same WR^2 is then suspended from the same wire and the time of the same number of oscillations is measured. The WR^2 of the disk is calculated, say from the chart, and the value for the tested object computed from:

WR^2 (unknown) =

$$WR^2 \text{ (known)} \times \left(\frac{\text{Time of unknown}}{\text{Time of known}}\right)^2$$

Figure 5 shows the general method. Care must be taken to have the wire long enough to make the time of each oscillation convenient to measure, and to twist the object in such a manner that it rotates about the support as its center. It is also important that the wire be firmly fixed at both ends so that it will not move in the supports, and that it has no bends at the supports.

Direct Measurement of WR^2

This method consists of setting up the object as a torsional pendulum, measuring its time of oscillation, its weight, the dimensions of the supporting means and computing the WR^2. Figure 6 shows the general set up. This method is perhaps the easiest to use in the field, as any wire, rope, string or chain can be used as supports if it is light compared to the weight of the object, and fairly flexible. A ruler, a watch and a set of scales are all that are necessary to take the measurements. If the object is not easily "hooked onto," a light platform can be suspended and its WR^2 determined. The object is then placed on the platform and the total WR^2 measured. The value for the unknown is found by subtracting that of the platform from the total.

The time "t" is the time for any convenient number of complete oscillations "N." A complete oscillation is the movement of the object from some one position back to the same position and traveling in the same direction. The computation is made from the formula shown at top of page 17.

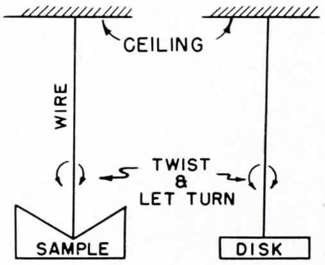


Fig. 5. Measured Comparison

Measured Comparison

$$WR^2 = \frac{.016\ WD^2t^2}{LN^2}\ \text{(lb ft squared)}$$

where

W = weight of object in pounds.

d = distance between supports in inches

L = length of supports in inches (should be at least 4 ft).

t = time in seconds for N oscillations.

Since the location of the decimal point is often confusing it is sometimes wise to make a rough calculation by the curve, Figure 2, as a check.

Connecting All WR^2 to One Shaft Speed

The effectiveness of WR^2 depends upon the speed at which it rotates. So, in any mechanical system, with shafts running at different speeds, the WR^2 must be reduced to some one shaft speed. For motor work, the motor shaft speed is usually used as the basis of comparison. In any event, it is always necessary to clearly state to what shaft it is referred, for example, "Flywheel WR^2 referred to motor shaft."

The formula for conversion is:

$$WR^2\ \text{(referred to shaft A)} = WR^2\ \text{(referred to shaft B)} \times \frac{(\text{Rpm of B})^2}{(\text{Rpm of A})^2}$$

Masses that are part of the system and that move in straight lines, must also be reduced to the reference shaft. The equivalent WR^2 of the lineally moving mass is:

$$WR^2 = \frac{WV^2}{(2\pi N)^2}$$

where W = weight of lineally moving part in pounds

V = velocity in fpm

N = rpm of reference shaft.

For example, the equivalent WR^2 of the simple hoist shown in Fig. 7 can be calculated as follows:

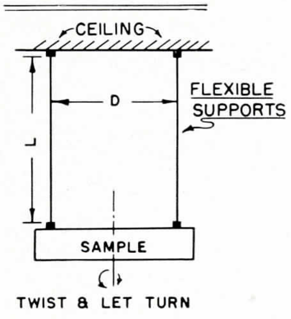


Fig. 6. WR^2 Measurement

$$WR^2 \text{ of sheave referred to motor shaft} = 18\left(\frac{600}{1800}\right)^2 = 2.00$$

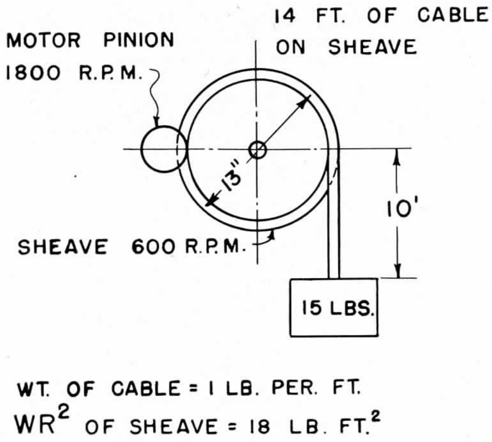

14 FT. OF CABLE ON SHEAVE
MOTOR PINION 1800 R.P.M.
13"
10'
SHEAVE 600 R.P.M.
15 LBS.
WT. OF CABLE = 1 LB. PER. FT.
WR2 OF SHEAVE = 18 LB. FT.2

Fig. 7.

WR^2 of cable on sheave referred to motor shaft =

$$14 \times 1 \times \left(\frac{13}{2 \times 12}\right)^2 \times \left(\frac{600}{1800}\right)^2 = .45$$

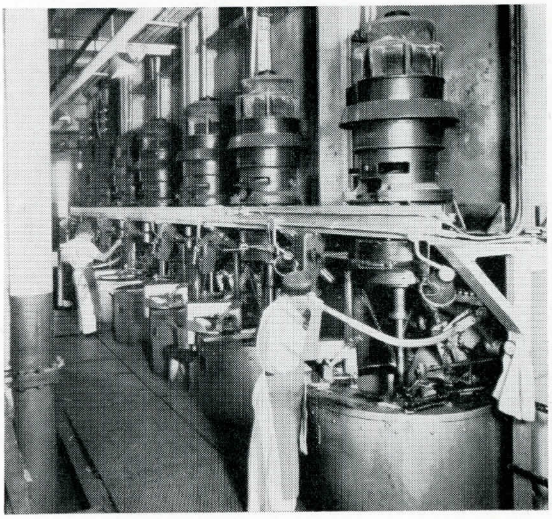
WR^2 of cable and weight (velocity = 2040 fpm) =

$$(15 + 10 \times 1)\left(\frac{2040}{2\pi 1800}\right)^2 = .82$$

$$\text{Total equivalent } WR^2 \text{ of system} = \overline{3.27}\ \text{lb.-ft}^2$$

Summary

The moment of inertia of an object or mass is extremely hard to estimate by merely looking at the object, because WR^2 varies as the fourth power of the diameter. At the same time WR^2 is an important item of the data necessary to apply a motor to some loads. Therefore it is hoped that the three methods of determining WR^2 shown here will be of some help to those who are concerned with seeing that the proper motor, neither too large nor too small, is applied to a machine.

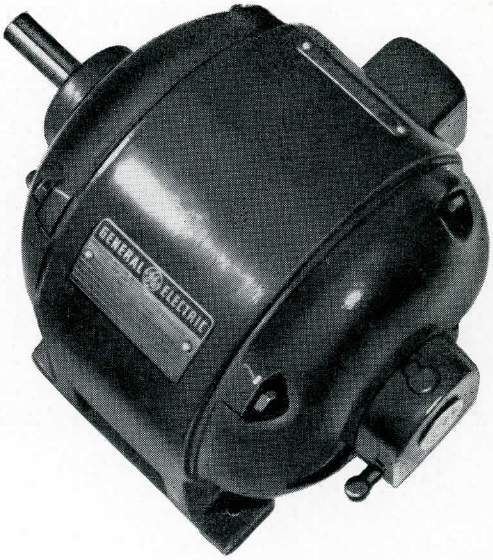


Vertical motors directly coupled to sugar centrifugals.

USE TRI/CLAD MOTORS
REG. U.S. PAT. OFF.
AS PART OF YOUR PRODUCT

The Tri-Clad motor was designed especially to meet the specific requirements of the builders and users of motor-driven machinery; its ultimate design was derived not only from General Electric's decades of experience in motor manufacture, but from the ideas and suggestions of industrial users as well. Consequently, the Tri-Clad motor has features providing extra advantages, at no price premium, for every kind of industrial user.

Although there are many different types, sizes, and ratings of Tri-Clad motors—each best suited to specific applications—*every one offers the same three distinctive advantages:*



The Tri-Clad polyphase induction motor has features providing extra advantages at no price premium.

1. EXTRA PROTECTION against Physical Damage

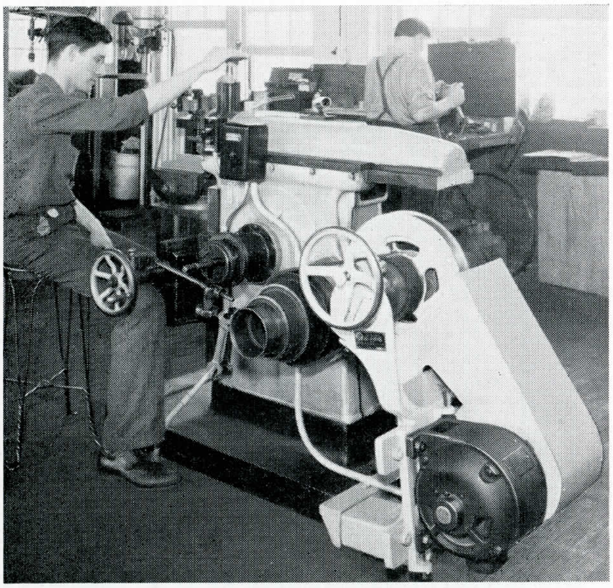
The strong one-piece, cast-iron frame and end shields, with upper portion completely enclosed, protect vital motor parts from external blows, flying chips, settling dust, and dripping liquids.

2. EXTRA PROTECTION against Electrical Breakdown

Stator windings of Formex wire give extra protection against moisture, oil, abrasion, and heat aging. The windings are compact—able to dissipate heat quickly, a process aided by the motor's system of double-end ventilation and correct baffling.

3. EXTRA PROTECTION against Operating Wear and Tear

The one-piece, cast-aluminum rotor winding, with integrally cast fans, is practically indestructible. Ball bearings are completely enclosed in cast iron, and long, close-running fits keep out dust, dirt and water. The newly designed sleeve bearings have long life expectancy and high load capacity because of new proportions and an efficient oil-distributing system.



Although this Tri-Clad motor is situated in an exposed location, its cast-iron frame and end shields (note rotated position), and its unusual degree of enclosure afford ample protection.

Just As Important . . .

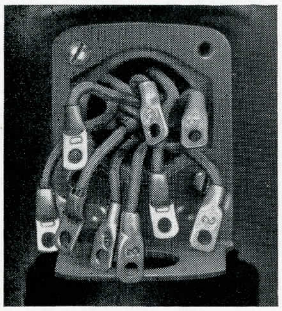
To you, the machinery manufacturer, the convenience and time-saving features, and the years-ahead design of the Tri-Clad motor are particularly important. No longer do you need to buy "specials" to get the advantages listed below:

Installation Is Easier, Quicker

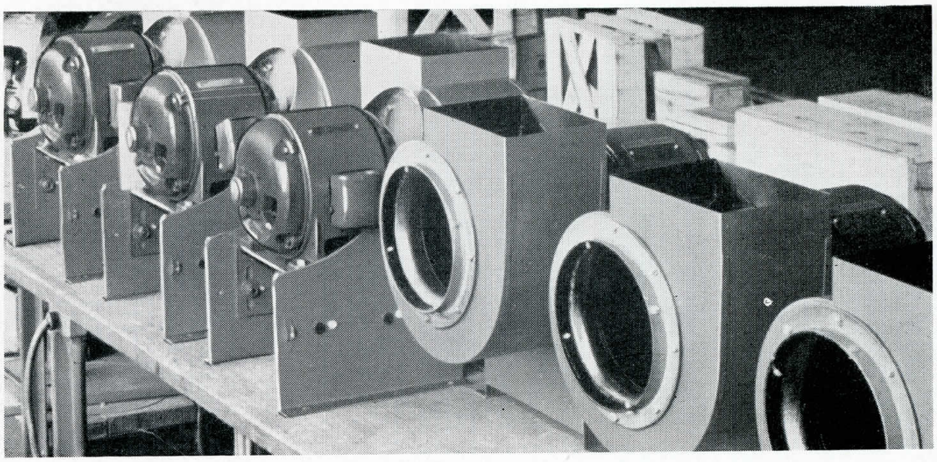
The stator of every Tri-Clad motor is easily reversible, permitting you to place the conduit box on the side that is better from the standpoint of convenience and appearance.

The rigid, cast-iron end shields can be rotated to any of four positions. You can thus take full advantage of the extra protection afforded by the complete enclosure of one half of the end shield. You simply rotate the end shield to the position where it offers the greatest protection. (See illustration on this page.)

This feature also permits you to mount sleeve-bearing motors with their feet at either side or above (provided the shaft is kept horizontal), because the oil housings can, in either case, be maintained in normal position.



Leads are permanently identified and fitted with terminals tightly pressed on.



Compactness, light weight, easy wiring, precision-machined mounting surfaces, and other Tri-Clad convenience features make a big difference on the assembly line.

Unrestricted working space is provided by the large, easily removable conduit box. And, as a further aid to neat, quick wiring, the conduit box can be placed in any of four positions, whichever conforms best to the direction of the lead-in conduit.

Leads are permanently and legibly identified, and all are fitted with terminals tightly pressed—not soldered—to the leads. A stainless-steel, plainly marked connection plate is conveniently located on the conduit-box side of the motor.

Because of its compactness and light weight, the Tri-Clad motor is easy to handle, both in the shipping room and on the assembly floor. Moreover, the light weight helps to reduce, in some measure, the shipping cost of the entire machine.

Dynamic Balance

Smooth motor operation is obtained and maintained because every Tri-Clad rotor is dynamically balanced. (Electrical and magnetic balance are accounted for in the design of the motor.) The rigid and substantial assembly of the Tri-Clad motor also contributes to this smoothness of operation that is such an essential attribute of motors to be included as part of a product.

Blends with Modern Machine Design

The smooth, protective contours of Tri-Clad motors harmonize with the trim appearance of modern machinery. In fact, because these motors are so well protected from falling dust and chips, the need for protective canopies and covers is often eliminated. In most cases, this benefits the over-all appearance of the machine.

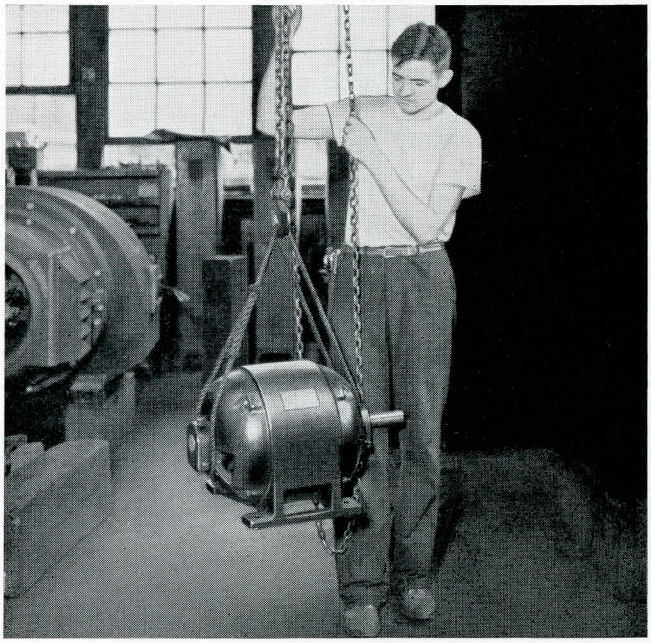
Built for Duty-cycle Operation

The definite trend in machine design toward severe duty-cycle operation imposes a heavy load on windings and bearings. In the Tri-Clad motor, these parts are particularly well suited to meet this growing practice.

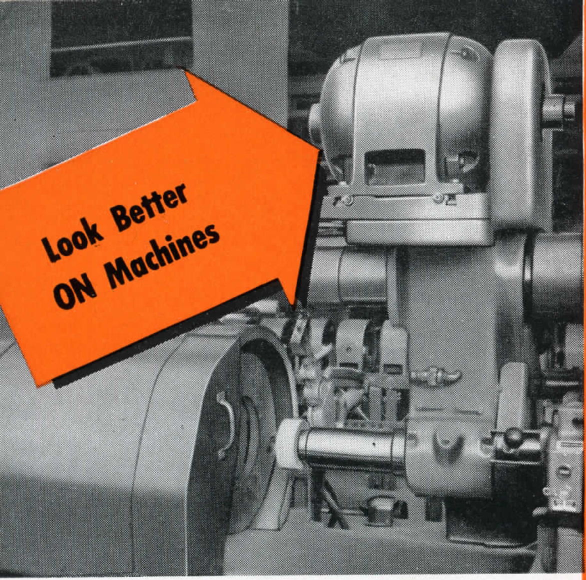
The windings are compact, well ventilated, and strongly bonded—able to dissipate heat and resist starting shocks through long years of continuous service. (Rotor designs made especially to produce many reversals per minute are available.)

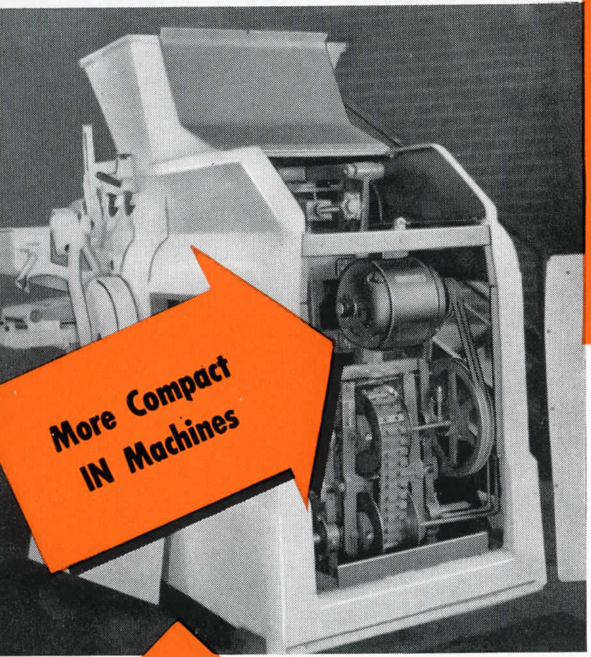
Ball bearings, enclosed in a single-joint, sealed housing, are kept free from foreign materials and maintained in proper alignment. The pressure-relief greasing system simplifies the process of getting the correct amount of fresh grease into the bearings.

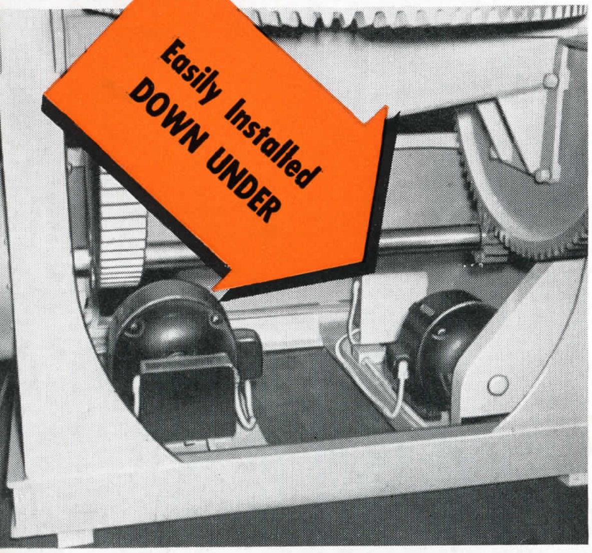
Sleeve bearing design assures ample bearing lubrication, regardless of the direction of rotation.



Tri-Clad motors are easy to handle. Even the bearing housings are conveniently shaped to accommodate slings and ropes.







TRI/CLAD

REG. U.S. PAT. OFF.

MOTORS

SIMPLIFY THE JOB

of designing or building machines

Note how the smooth, trim contours of Tri-Clad motors will blend with the modern appearance of your machines.

They can be mounted in exposed locations close to cutting tools because their sturdy, cast-iron frames and end shields give them ***extra*** protection against physical damage from chips and spattering coolants.

Their compactness is a valuable asset when your design allows only limited space for the motor drive, or when the reduction of shipping weight means money saved.

Tri-Clad motors are a cinch to install. Primarily because of the shape of the bearing housings, they are easily handled by hand or with slings. Their roomy conduit boxes give ample wiring space, and all leads have terminals and are clearly identified. Their end-shield design permits mounting horizontal types in any of four positions.

In addition, all Tri-Clad rotors are dynamically balanced as one important step in their manufacture to facilitate over-all operating smoothness of machine and motor.

While the standard, open type (now available to 100 hp) will meet a wide range of design requirements, Tri-Clad motors are also available in splashproof and vertical types with face- or flange-type end shields. Ask your G-E representative about types and ratings. *General Electric, Schenectady, N. Y.*

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